General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.

- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.

- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.

- This document is paginated as submitted by the original source.

- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

Produced by the NASA Center for Aerospace Information (CASI)

02

"Made available under NASA sponsorship
In the interest of early and wide dissemination of Earth Resources Survey
Program information and without liability
for any use made thereof."

II

E7.6-10347
CR-147238

Processing of Landsat Imagery for Dissemination Purposes

Hugh B. Loving and Alden P. Colvocoresses
U.S. Geological Survey
Reston, Virginia 22092

15 April 1976

Progress Report 8/18/75 - 5/1/76

(E76-10347) PROCESSING OF LANDSAT IMAGERY FOR DISSEMINATION PURPOSES Progress Report, 18 Aug. 1975 - 1 May 1976 (Geological Survey, Reston, Va.) 5 p HC $3.50 CSCL 05B

N76-24667

G3/43

Unclas
00347

Prepared for
NASA/Goddard Space Flight Center
Greenbelt, Maryland 20771

Publication authorized by the Director, U.S. Geological Survey

23650

RECEIVED
MAY 21 1976
SIS/902.6

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Processing of Landsat Imagery for Dissemination Purposes No. 23650		5. Report Date April 15, 1976 6. Performing Organization Code
7. Author(s) Hugh B. Loving and Alden P. Colvocoresses		8. Performing Organization Report No.
9. Performing Organization Name and Address U.S. Geological Survey National Center #522 Reston, Virginia 22092		10. Work Unit No. 11. Contract or Grant No. S-539-99
12. Sponsoring Agency Name and Address NASA/Goddard Space Flight Center Greenbelt, Maryland 20771		13. Type of Report and Period Covered Progress Report 8/18/75 - 5/1/76 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Recent tests with digitally enhanced Landsat imagery indicate that far greater information content can be obtained in photographic form than is possible with conventional imagery. Meaningful distinctions between MSS bands 4 and 5 can thus be achieved and items such as dormant vegetation can be uniquely recorded in color image form.

ORIGINAL PAGE IS
OF POOR QUALITY

17. Key Words (Selected by Author(s))	18. Distribution Statement		
spectral band enhancement, contrast improvement, photographic processing, digital processing.			
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Not Applicable		

*For sale by the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

Figure 2. Technical Report Standard Title Page

Progress Report

a. Title - Processing of Landsat Imagery for Dissemination Purposes

b. GSFC I.D. No. 23650

c. Problem areas

Problems are basically the same as previously reported August 18, 1975. Problems indicated in the 1 April 76 report on experiment No. 23960 (Overall Evaluation of Landsat (ERTS) Follow-on Imagery for Cartographic Application) are also pertinent. As indicated in these reports, the critical problem is the determination of when and how to convert Landsat signals from digital to analog form. Until NASA/ Goddard completes the requested testing of enhanced processing through their EBR, this problem cannot be solved.

d. Accomplishments

As previously reported, photographic enhancement of conventional Landsat imagery is being explored. The principal accomplishment during this period is in color treatment. Tests show that the conventional combining of bands 4, 5, and 7 into a color composite is not optimum. For both photographic and lithographic color treatments, further objective tests must be evaluated by competent user representatives before standards for Landsat photographic products are established.

Experimental reprinting of Upper Chesapeake Bay (copy attached to EC-34-Landsat), although lithographic, provided insight to the photographic processes as well. The experiment clearly shows that Landsat imagery as now produced in conventional form by Goddard and the EROS Data Center is not optimum. The Upper Chesapeake Bay imagery was digitally enhanced (precision processed by IBM) and results in far greater information content than could be obtained from the conventional imagery. In this case, the differences between bands 4 and 5 (which were lost in conventional processing) were enhanced to the point that dormant vegetation is recorded as green in color composites. A chart based on the responses and treatment applied to Upper Chesapeake Bay, in simplified form, is enclosed as figure 1. It is noted that some color composites produced by Goddard show response similar to that achieved by IBM precision processing but at a somewhat reduced level of information content. The EROS Data Center, JPL, and others using digital resampling procedures are obtaining enhancements similar to that of IBM. A memorandum summarizing such activities as they relate to cartography, EC-32-Landsat, has been prepared.

e. Significant results

The only significant result to report during this period is the differentiation between bands 4 and 5 achieved through enhancement. Depiction of dormant vegetation on the Upper Chesapeake Bay image map in tones of green is an example of a significant difference between bands 4 and 5 which can be achieved through proper enhancement.

f. Publications and reports

See section f of progress report of 1 April 1976, of experiment No. 23960, "Overall Evaluation of Landsat (ERTS) Follow-on Imagery for Cartographic Application."

g. Recommendations

In addition to previous recommendations, it is now recommended that image enhancement be further investigated and, where justified, applied to the standard processing of Landsat imagery which is distributed to the public in photographic form.

h. Not applicable

i. Not applicable

j. Not applicable

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

ORIGINAL PAGE IS
OF POOR QUALITY

28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
JUN 1976
RECEIVED
NASA STI FACILITY
INPUT BRANCH

Simplified Diagram of the Development of Color Composites based on Subtractive Application of Green, Red, and Near IR Response
(Positive Record, 3-bands)

Object Type		Cleared Area (Highly reflective)			Urban Areas			WATER Turbid or Shallow			WATER Clear and Deep			Growing Vegetation (IR reflective)			Dormant Vegetation		
Spectral band (wavelength)		Green 0.5 - 0.6 µm	Red 0.6 - 0.7 µm	Near IR 0.7 - 1.1 µm	Green 0.5 - 0.6 µm	Red 0.6 - 0.7 µm	Near IR 0.7 - 1.1 µm	Green 0.5 - 0.6 µm	Red 0.6 - 0.7 µm	Near IR 0.7 - 1.1 µm	Green 0.5 - 0.6 µm	Red 0.6 - 0.7 µm	Near IR 0.7 - 1.1 µm	Green 0.5 - 0.6 µm	Red 0.6 - 0.7 µm	Near IR 0.7 - 1.1 µm	Green 0.5 - 0.6 µm	Red 0.6 - 0.7 µm	Near IR 0.7 - 1.1 µm
Response (relative)		high	high	high	high	high	low	high	high	low	low	low	low	low	low	high	low	high	low
Color application subtractive from white, yellow applied to green, magenta to red, cyan to near IR	yellow (-blue)	white	-	-	white	-	-	white			yellow	-	-	yellow	-	-	yellow	-	-
	magenta (-green)	-	white	-	-	white	-		white		-	magenta	-	-	magenta	-	-	white	-
	cyan (-red)	-	-	white	-	-	cyan			cyan	-	-	cyan	-	-	white	-	-	cyan
Color, to observer, of the three bands combined		white			cyan			cyan			black			red			green		

Figure 1